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GROWTH PERFORMANCE AND BLOOD CONSTITUENTS OF BROWN AND WHITE JAPANESE QUAIL REARED UNDER HEAT STRESS CONDITIONS

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ABSTRACT : The present study aimed at the evaluation of growth performance, carcass characteristics and related physiological aspects of two different quail genotypes reared under different environmental conditions. A total of 180 quail birds, 8 days of age, of brown and white genotypes were used in this study and divided into two equal groups. Each genotype group was further divided into two subgroups; one subgroup of each genotype was subjected to cyclic heat stress (34˚C/8h, then 24˚C/16h), and the other subgroup was reared under control environment condition (24±1˚C) and served as the control. Feed intake, body weight gain and feed conversion ratio were determined and carcass characteristics were obtained. Blood samples were collected to measure total protein, albumin, cholesterol, triglycerides, AST, ALT, calcium, phosphorus, H/L ratio and total white blood cells. Also, tibia ash, calcium and phosphorus contents were determined. Rectal temperature was recorded. The effect of genotypic variation was noticed in all growth traits and carcass characteristics, revealing that white quail was higher in meat production. The results showed that heated stressed white quail had higher ($P<0.01$) initial and final body weight than brown quail. The effect of heat stress conditions on blood constituents was prominent. The effect of genotype on blood constituents was not observed, except for the total protein, calcium, AST and ALT. It can be concluded that the white quail genotype has the potential to deposit more meat, especially under high environmental temperature.

Keywords: quail genotype – performance – physiology - heat stress.

INTRODUCTION

Quail are the smallest avian species that are raised for meat and egg production with their unique flavor. The economic importance of quail is related to its low cost of maintenance, short generation interval and high resistance to diseases (Vali, 2008). There are about 70 domestic quail breeds around the world (Chang et al., 2005). Mansour et al. (2010) reported that the brown plumage phenotype was the original color from which the other colors had segregated, and that roux and white phenotypes are genetically close to the brown plumage. Akintan et al. (2017) used protein markers to characterize Japanese quail and reported that the white and brown quail populations have genetic similarity indicating that the two populations are genetically related. It was concluded that selection for body weight in quail can be practiced during the early growing phase (Silva et al., 2013). Le Bihan-Duval et al. (2008) studied the effect of selection in improving meat characteristics of meat-type chickens. They confirmed that selection is useful to improve meat characteristics without impairing profitability. Genchev et al. (2005) studied the fatting capacity and the meat quality of the White English breed and the meat Faraon breed and reported that the White English quail breed is suitable for producing both of eggs and meat.

Heat stress directly reduces feed intake and subsequently deteriorate the bird metabolic matrix leading to impairing productivity. Alagawany et al. (2017) reported that heat stress have deleterious impacts on body weight, growth rate, feed intake, feed efficiency, egg production and egg mass in different quail breeds. Jahejo et al. (2016) reported a significant reduction in feed intake, weight gain and dressing percentage of Hubbard chicken subjected to heat stress conditions at 35-38˚C. Soleimani et al. (2011) concluded that domestication and selective breeding in birds increase susceptibility to stress conditions. Moreover, they suggested that genetic differences in body size and age are not limiting factors in response to heat stress conditions. Lara and Rostagno (2013) explained the variation in the response of birds to heat stress conditions to be due to the use of birds of different age or genetic background and duration of the heating period. The present study aimed at the evaluation of growth performance and blood constituents of two genotypes of Japanese quail reared under thermo-neutral or cyclic heat stress conditions.

MATERIALS AND METHODS

A total of 180 Japanese quail, 90 chicks of white quail and 90 chicks of brown quail, at 8 days of age were recruited from the poultry farm in the Faculty of agriculture, Cairo University. The quail of each genotype were divided into two equal subgroups; one subgroup was subjected to cyclic heat stress (3 replicates of 15 birds each) and the other subgroup served as the control. The heat-stressed birds of both genotypes were reared under controlled environmental conditions, where the ambient temperature was risen to reach 34±1˚C for 8 hours daily and then decreased to reach 24±1 ˚C for 16 hours. The control subgroups were reared under 24±1˚C for the entire experimental period. The experimental birds were reared in wired cages 40×50 cm^2/replicate. All quail groups were fed ad libitum a basal diet containing 23.61% crud protein and 3066.79 kcal/kg ME.

Growth performance

Body weights were recorded at 8, 21, 35 and 42 days of age and body weight gain was calculated for each subgroup in each period. Feed intake was recorded and feed conversion was calculated for each subgroup.

At 42 days of age, three birds were randomly chosen from each replicate (a total of 9 birds per group), subjected to feed withdrawal for eight hours and then slaughtered. Carcasses were chilled and weighted while the edible parts (gizzard, heart and liver) were separated and weighed. The abdominal fat and total carcass fat were separated and weighed. Carcass, giblets, abdominal fat and total fat were expressed as percentages of live body weight at slaughter.

Physiological parameters

At the end of the experiment, nine birds from each group (3 birds/replicate) were slaughtered and blood samples were collected in heparinized tubes. Plasma was separated and stored at -20˚C until further analysis. Plasma total protein, albumin, cholesterol, triglycerides, ALT, AST, calcium and phosphorus were measured using kits (Salucea, Haansberg, Netherlands). The plasma biochemical parameters were measured using spectrophotometer (CE1010, Cecil Instruments Limited Cambridge, UK) using colorimetric assay kits (Salucea, Haansberg, Netherlands).

Tibia ash percentage was determined according to AOAC International (2005), where tibia pieces were collected, defatted, and ashed at 600°C for 16 h to determine ash percentage. Total phosphorus in the samples was determined using the colorimetric method according to Onyango et al. (2003). Briefly, samples were ashed and boiled in acid to dissolve all phosphorus. The concentration of phosphorus in the supernatant was determined using a kit. Ammonium molybdate was added to the supernatant to form phosphomolybdate, which was then reduced to form a blue phosphomolybdenum complex. Color intensity of the complex was proportional to the phosphorus concentration and was determined with a spectrophotometer using absorption at 620 nm. Calcium was determined by flame atomic absorption spectroscopy.

Statistical analysis

The statistical analyses were performed using IBM SPSS 22.0 Software Package (IBM corp., NY, USA, 2013). Two-way ANOVA was used to analyze the main effects of genotype (GT), heat stress (HS) and their interactions (GT×HS) on the production traits, carcass characteristics and blood constituents. When significant differences due to the GT, HS or their interaction were detected, a multiple pairwise comparison among treatment groups was performed using Tukey's HSD test and the level of statistical significance was set at $P<0.05$.

RESULTS AND DISCUSSION

Production performance

Body weight gains (BWG), feed intake (FI) and feed conversion ratio (FCR) of brown and white quail at different periods of the experiment are presented (Table 1). The white quail significantly had higher initial body weight at 8 days of age than their counterpart brown quail in both heating treatments. Islam et al. (2014) reported a significant higher weight of chick form white genotype quail compared to brown genotype. Genotype differences were also found in BWG, FI and FCR. The white quail control group had the highest BWG, at all the experimented periods, and the heat-stressed white quail had higher BWG than the brown quail control and heat-stressed groups. Feed intake significantly decreased in heat stress treatment in the white and brown quail. Del Vesco et al. (2017) reported a significant reduction in feed intake and body weight gain in quail exposed to chronic heat stress (38˚C/24h) compared to the comfort non-stressed group (25˚C). Ali et al. (2016) reported that the white quail was significantly heavier that the brown quail at 2, 4 and 6 weeks of age.

The white quail had better FCR compared to brown quail during periods from 22-35 days and 36-42 days of age. Heat stress impaired FCR in both white and brown quail although not significantly except in white quail at 22-35 days of age. Alagawany et al. (2017) stated that heat stress decrease feed efficiency in different quail species. In laying quail, exposure to cyclic heat stress significantly impaired FCR (Vercese et al., 2012).

Carcass characteristics

Carcass characteristics of the brown and white Japanese quail reared under cyclic heat stress are presented in Table (2). The genotype effect played a significant role in all carcass characteristics. On the other hand, heat stress conditions significantly affected all carcass measurements, except total body fat percentage. A significant effect of genotype × heat stress interaction was observed in carcass weight and dressing percentage. The white quail had the highest live body weight, carcass weight, giblets weight, dressing percentage, abdominal fat and total body fat than the brown quail under the thermo-neutral conditions. Toelle et al. (1991) reported positive genetic correlation between body weight and abdominal fat, suggesting that selection for increasing body weight causes more deposition of abdominal fat. Under heat stress conditions, all carcass measurements significantly decreased for both white and brown quail, except giblets weight and body fat percentage of carcass weight.

The abdominal fat and total body fat were significantly higher in the white control group and decreased significantly under heat stress conditions. The selection for high live body weight at 45 days of age led to high deposition of abdominal fat and fat content in the meat in different lines of quail subjected to mass selection (Caron et al., 1990).

Blood parameters and tibia minerals composition

Blood parameters, tibia ash, calcium and phosphorus contents and rectal temperature of brown and white Japanese quail under different environmental temperatures are presented in Table (3). There was no effect of genotype × heat stress interaction in any of the studied parameters. Cholesterol, triglycerides and phosphorus levels were not affected by any of genotype or heat stress differences. Meanwhile, significant effect of genotype and heat stress was noticed in blood total protein, AST and ALT levels. It seems that the white genotype quail has higher plasma total protein level than the brown genotype, while heat stress conditions did not affect total protein level. Meanwhile, total protein in the brown genotype significantly declined with heat stress conditions. Blood albumin and white blood cells significantly decreased in the white quail under heat stress conditions compared to the control group by 19 and 28%, respectively. Mahmoud et al. (2013) reported a significant reduction in WBCs in quail exposed to heat stress for 15 days during the 5^{th} and the 6^{th} weeks of ages. AST was significantly lower in the control group of white quail compared to the control group of brown quail. The levels of AST and ALT increased in both quail genotypes in response to exposure to heat stress conditions, compared to the control groups.

Heat stress significantly increased H/L ratio in the brown and white quail when compared to their control groups. A significant elevation in H/L ratio and significant reduction in white blood cells were reported in quail subjected to 35˚C from 28 to 35 days of age compared to the control group by 50 and 26%, respectively (Mehaisen et al., 2017). Mahmoud et al. (2013) found that H/L ratio in Japanese quail linearly increased (from 0.27 to 0.74) with the increase in the ambient temperature (from 22 to 40℃).

Tibia ash and calcium contents decreased in both genotypes under heat stress conditions compared to the corresponding controls. Tibia content of phosphorus also decreased in both genotypes under heat stress conditions, but the differences between the heat-stressed groups and the controls were insignificant. Sahin et al. (2003 and 2004) reported a significant reduction in calcium and phosphorus retention and significant elevation in both elements execration in quail reared under cyclic heat stress condition (8h at 34˚C and 16h at 18-22˚C) for 32 days.

Rectal temperature significantly increased upon heat stress exposure. Significant increase in body temperature was also reported by Del Vesco et al. (2017) in quail subjected to heat stress conditions (38˚C).

CONCLUSION

Our results reveal that white quail is fast grown than brown quail. Furthermore, under heat stress conditions the white quail showed less susceptibility to heat stress conditions, and hence showed higher performance. Further investigations are needed to study the genetic variation between the white Japanese and brown Japanese quail in meat production.

Table (1): Growth performance of brown and white quail genotypes under thermo-neutral and heat stress conditions.

Items	Treatment groups				SEM	Main effects		
	Brown		White					
	C	HS	C	HS		GT	HS	GT×HS
Initial weight, g	31.60^{b}	31.80^{b}	33.40^{a}	33.11^{a}	0.37	S	NS	NS
Final weight, g	252.2^{c}	221.4^{d}	314.8^{a}	278.6^{b}	2.43	S	S	NS
BWG, g/bird								
8-21d	87.3^{c}	76.6^{d}	103.4^{a}	88.8^{b}	0.06	S	S	S
22-35d	101.5^{c}	85.5^{d}	126.0^{a}	109.5^{b}	0.06	S	S	NS
36-42d	31.82^{c}	27.51^{d}	52.00^{a}	46.85^{b}	0.11	S	S	NS
Feed intake, g/bird								
8-21d	192.92^{b}	174.58^{c}	218.17^{a}	193.62^{b}	1.09	S	S	NS
22-35d	292.32^{b}	251.35^{d}	313.74^{a}	282.52^{c}	0.77	S	S	S
36-42d	108.78^{c}	95.97^{d}	162.26^{a}	151.06^{b}	0.40	S	S	NS
Feed conversion								
8-21d	2.21^{ab}	2.28^{a}	2.11^{b}	2.18^{ab}	0.01	S	NS	NS
22-35d	2.88^{a}	2.94^{a}	2.49^{c}	2.58^{b}	0.01	S	S	NS
36-42d	3.42^{a}	3.49^{a}	3.12^{b}	3.20^{b}	0.01	S	S	NS

Means, within the same row, with different superscripts are significantly different ($P<0.05$).
SEM: standard error of the mean. BWG: body weight gain.
C: control subgroups that were reared under thermo-neutral condition 24˚C; HS: heat stress subgroups that were reared under cyclic heat stress 8h at 34˚C and 16h at 24˚C.

Table (2): Carcass characteristics of brown and white quail genotypes under thermo-neutral and heat stress conditions.

Characteristics	Treatment groups				SEM	Main effects		
	Brown		White					
	C	HS	C	HS		GT	HS	GT×HS
LBW, g	253.7^{c}	224.2^{d}	316.2^{a}	280.2^{b}	2.98	S	S	NS
Carcass weight, g	178.5^{c}	152.1^{d}	231.4^{a}	196.6^{b}	0.82	S	S	S
Giblets weight, g	12.20^{b}	11.80^{b}	14.60^{a}	14.10^{a}	0.08	S	S	NS
Dressing, %	75.20^{b}	73.10^{c}	77.80^{a}	75.20^{b}	0.06	S	S	S
Abdominal fat, g	0.94^{c}	0.72^{d}	1.42^{a}	1.14^{b}	0.02	S	S	NS
Total body fat, g	1.64^{c}	1.32^{d}	2.62^{a}	2.11^{b}	0.04	S	S	NS
Total body fat, %*	0.92^{b}	0.87^{b}	1.14^{a}	1.08^{a}	0.02	S	NS	NS

Means, within the same row, with different superscripts are significantly different (P<0.05).
SEM: standard error of the mean. LBW: live body weight at slaughter.
C: control subgroups that were reared under thermo-neutral condition 24˚C; HS: heat stress subgroups that were reared under cyclic heat stress for 8h at 34˚C and 16h at 24˚C.
*Parameters were calculated as a percentage of carcass weight.

Table (3): Blood constituents, tibia ash, calcium and phosphorus contents and rectal temperature of brown and white quail genotypes under thermo-neutral and heat stress condition.

Parameters	Treatment groups				SEM	Main effects		
	Brown		White					
	C	HS	C	HS		GT	HS	GT×HS
Total protein, g/dl	5.14^{a}	4.19^{b}	5.94^{a}	5.12^{ab}	0.12	S	S	NS
Albumin, g/dl	2.66^{ab}	2.29^{b}	3.12^{a}	2.54^{b}	0.06	NS	S	NS
Cholesterol, mg/dl	148.6	141.8	152.6	146.3	3.21	NS	NS	NS
Triglycerides, mg/dl	266.8	258.2	275.4	270.8	4.30	NS	NS	NS
Calcium, mg/dl	10.52^{ab}	8.62^{b}	12.48^{a}	10.58^{ab}	0.28	S	S	NS
Phosphorus, mg/dl	6.94	5.92	7.78	6.38	0.34	NS	NS	NS
AST, U/l	33.16^{b}	39.86^{a}	26.52^{c}	32.62^{b}	0.57	S	S	NS
ALT, U/l	23.22^{bc}	29.56^{a}	20.11^{c}	24.82^{b}	0.59	S	S	NS
H/L ratio	0.45^{c}	0.53^{ab}	0.49^{bc}	0.56^{a}	0.01	NS	S	NS
WBC, $\times 10^3$/mm^3	96.8^{ab}	78.2^{ab}	100.8^{a}	72.2^{c}	3.38	NS	S	NS
Tibia ash, %	48.23^{ab}	42.53^{c}	49.92^{a}	43.83^{bc}	0.58	NS	S	NS
Tibia calcium, %	13.65^{ab}	10.45^{c}	14.25^{a}	11.17^{bc}	0.37	NS	S	NS
Tibia phosphorus, %	9.33^{ab}	7.43^{b}	9.83^{a}	7.53^{ab}	0.29	NS	S	NS
Rectal temperature	40.70^{b}	41.20^{a}	40.70^{b}	41.10^{a}	0.04	NS	S	NS

Means, within the same row, with different superscripts are significantly different ($P<0.05$).

SEM: standard error of the mean.

C: control subgroups that were reared under thermo-neutral condition 24˚C; HS: heat stress subgroups that were reared under cyclic heat stress 8h at 34˚C and 16h at 24˚C.

quail genotype – performance – physiology - heat stress.

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quail genotype – performance – physiology - heat stress.

الملخص العربى

الأداء الإنتاجى ومكونات الدم للسمان اليابانى البنى والأبيض المربى تحت ظروف الإجهاد الحرارى

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أستهدفت الدراسة الحالية دراسة الأداء الإنتاجى وصفات الذبيحة وبعض النواحى الفسيولوجية المتعلقة بأثنين من التراكيب الوراثية المختلفة للسمان اليابانى تحت ظروف بيئية مختلفة. تم استخدام عدد 180 من السمان الأبيض والبنى قسمت على مجموعتان متساويتان. كل مجموعة تم تقسيمها عشوائياً إلى مجموعتان متماثلتان أحد هذه المجموعتين تم تعريضها إلى إجهاد حرارى (34 درجة مئوية لمدة 8 ساعات ثم 24 درجة مئوية لمدة 16ساعة) أما المجموعة الأخرى ربيت تحت ظروف حرارية معتدلة (24 درجة مئوية) واستخدمت كمجموعة كنترول. تم تقدير كل من كمية الغذاء المأكول، الزيادة فى وزن الجسم وكفاءة تحويل الغذاء وتم تسجيل درجة حرارة الجسم وتقدير صفات الذبيحة كما تم تجميع عينات من الدم لتقدير كل من البروتين الكلى، الألبيومين، الكوليستيرول، الجلسريدات الثلاثية، انزيمات الكبد، الكالسيوم، الفسفور ونسبة الهتيروفيل إلى الليمفوسيت والعدد الكلى لكرات الدم البيضاء. وأيضاً تم تقدير محتوى الرماد والكالسيوم والفوسفور فى عظمة الساق. أظهرت النتائج أن وزن البداية والوزن النهائى كان أعلى فى السمان الأبيض مقارنة بالسمان البنى. بغض النظر عن المعاملة الحرارية كان تأثير التباين الوراثى ملحوظ فى كل الخواص الإنتاجية وصفات الذبيحة فى مختلف فترات التجربة والتى أظهرت أن السمان الأبيض كان الأفضل فى إنتاج اللحم. تحت ظروف الإجهاد الحرارى أظهر السمان الأبيض إنخفاض أقل فى الإنتاج إذ ما قورن بالسمان البنى. مكونات الدم تأثرت بشكل أساسى بالتعرض للإجهاد الحرارى عن الإختلاف الجينى ماعدا فى البروتين الكلى، الكالسيوم، إنزيمات الكبد التى تأثرت بكل من الإجهاد الحرارى والإختلاف الجينى على حد سواء. ومن هنا يمكن استنتاج أن السمان الأبيض لديه القدرة على أن يستخدم فى إنتاج اللحم خصوصاُ تحت ظروف الأرتفاع فى درجة حرارة البيئة.